DOCUMENT RESUME

ED 139 610 SE 022 255

AUTHOR Ogden, William R.; Brewster, Patricia M.
TITLE An Analysis of Cognitive Style Profiles and Related Science Achievement Among Secondary School Students.
PUB DATE Mar 77
NOTE 25p.; Paper presented at the annual meeting of the National Association for Research in Science Teaching (50th, Cincinnati, Ohio, March 22-24, 1977)

EDRS PRICE MF-$0.83 HC-$1.67 Plus Postage.
DESCRIPTORS *Academic Achievement; Cognitive Processes; *Cognitive Style; *Educational Research; Science Education; Scientific Attitudes; Secondary Education; *Secondary School Science; *Success Factors
IDENTIFIERS Research Reports

ABSTRACT

The purpose of this study was to identify cognitive styles for successful and unsuccessful science students at the secondary level. Additional purposes were to identify common and unique elements in these composite cognitive styles and to substantiate the description of the groups of successful and unsuccessful science students according to the variables: science achievement, knowledge of the processes of science, and attitude toward science. Sex differences were also considered. The sample included 351 tenth, eleventh, and twelfth grade students. Each student was administered the Test of Academic Progress, the Wisconsin Inventory of Science Processes, and an adaptation of the Hartman Science Attitude Test. The cognitive style of each individual was mapped using the Cognitive Style Mapping Booklet. Statistical analysis showed significant differences for nine sets of variables, including: (1) achievement in science for successful and unsuccessful science students; (2) cognitive styles of successful and unsuccessful science students at the secondary level; (3) cognitive styles of male and female successful and unsuccessful students; and (4) cognitive styles of successful and unsuccessful science students at different grade levels in the secondary school. (MH)

****
* Documents acquired by ERIC include many informal unpublished *
* materials not available from other sources. ERIC makes every effort *
* to obtain the best copy available. Nevertheless, items of marginal *
* reproducibility are often encountered and this affects the quality *
* of the microfiche and hardcopy reproductions ERIC makes available *
* via the ERIC Document Reproduction Service (EDRS). EDRS is not *
* responsible for the quality of the original document. Reproductions *
* supplied by EDRS are the best that can be made from the original. *
****

ED139610

U S DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

AN ANALYSIS OF COGNITIVE STYLE PROFILES AND RELATED SCIENCE ACHIEVEMENT AMONG SECONDARY SCHOOL STUDENTS

William R. Ogden
East Texas State University
Commerce, Texas 75428

and

Patricia M. Brewster
Mesquite ISD
Mesquite, Texas 75149

Presented at
National Association for Research
in Science Teaching
Cincinnati, Ohio
March 23, 1977

SE 022 255

INTRODUCTION

Bruner (1966:127) acknowledged that the "texture of learning is different for each individual." According to Bruner (1966:21):

> . . . the heart of the educational process consists of providing aids and dialogues for translating experience into more powerful systems of notation and ordering.

He indicated (1966:127) that the schools most often "fail to enlist the natural energies of individuals which sustain learning," and (1966:53) that "if information is to be used effectively, it must be translated into the learner's ways of attempting to solve a problem."

In discussing the effectiveness of learning experiences, Tyler (1933:288) has observed:

> No one series of learning experiences has proved equally effective with all students [;] . . . the expansion of learning activities should be supplemented by a means of discovering for the students where their difficulties are and of suggesting what kinds of activities will be most helpful to them in overcoming these difficulties in learning.

An analysis of the cognitive style of an individual can provide this supplementation which Tyler described (Hill, 1969:6-7). Allport (1937:306) was the first to allude to "style" in learning. Since that time, the concept of cognitive style described in the literature has assumed a variety of dimensions.

The concept of cognitive style employed in this study was that of Hill (1969:14) which lies within the framework of his "Educational Sciences." Cognitive Style as defined by Hill (1973:3,6) is determined by the way an individual takes note of his total surroundings, how he seeks meaning and becomes informed; it is represented by the Cartesian product of the first four strata of the "Educational Sciences": symbols and their meanings, cultural determinants, modalities of inference, and memory concern. In practice at this time, only the first three of these strata are employed in the diagnosis of the cognitive style of an individual (Hill, 1973:6). A cognitive style map (see p.) provides a description of the learning strengths of an individual--the way he derives meaning from his environment. It is unique to the individual.

Taba (1962) described a trend in curriculum development to work on a "piecemeal basis." If education is to aid each individual in the realization of his maximum potential, then the fundamental "piece" to be considered by the curriculum planner must be the individual. Hence, the more knowledge there is available to describe how the individual interacts with the content of the particual curriculum area under consideration, the more provision that can be made for the utilization of the "natural energies of individuals" described by Bruner (1966:53) to facilitate the learning process.

METHODOLOGY

The major purpose of this study was to identify composite cognitive styles for successful and unsuccessful science students at the secondary level. Additional purposes were to substantiate the description of these two groups and to identify the unique and common elements within the cognitive styles of each group which might have implications for the secondary science curriculum. These purposes were considered for the groups identified as successful and unsuccessful science students within the total sample, within grade levels ten, eleven, and twelve, and for males and females in each of the previous categories. The variables of science achievement, knowledge of the scientific enterprise, and attitude toward science were also measured.

The procedure followed in conducting the study was:

1. administration of an instrument to identify successful and unsuccessful science students within the sample population,
2. administration of a test battery to further describe the groups of successful and unsuccessful science students,
3. administration of a cognitive style mapping instrument from which information was collected to construct composite cognitive styles and identify unique and common elements within these styles, and
4. statistical analysis of the data.

DEFINITIONS

Cognitive Style

Cognitive Style combines the information included in the first four "Educational Sciences," by means of a Cartesian product of these four sets, to provide a picture of the profiles distributed over the four sets that an individual employs in seeking meaning (Hill 1969:15). At the present time only the first three sets--symbolic orientation, cultural determinants of the meaning of symbols, and modalities of inference--are sampled. Instruments for collecting information relative to the set, memory concern, are under construction (Hill, 1973:6).

Cognitive Style Map

A cognitive style map is a computer printout which is a description of the way in which an individual derives meaning from his environment. It is constructed to indicate major, minor, and negligible orientations for each element in each of the sets of the Cartesian product which constitutes an individual cognitive style according to the principles described by Hill (1969:16-19).

Common Element of Cognitive Style

A common element of a composite cognitive style is an element which appears in the composite cognitive style of both the "successful" and the "unsuccessful" science students.

Composite Cognitive Style

A composite cognitive style is composed of elements which appear in 70 percent (Hoogasian, 1970; Shuert, 1970; Blanzy, 1970; Warner, 1970) of a group of individual cognitive styles. A composite cognitive style is considered representative of the group from which it was drawn (Shuert, 1970:114-115).

Cultural Determinants of Cognitive Style

Cultural determinants are environmental factors which influence the meanings one assigns to symbols in deriving meaning and acquiring knowledge (Hill, 1969:4).

Educational Sciences

The Educational Sciences are a conceptual framework and universe of discourse for the applied field of education developed by Joseph Hill and his associates (Blosser, 1971:26). The Educational Sciences are composed of seven areas which are defined by Hill as symbols and their meanings; cultural determinants of the meaning of symbols; modalities of inference; selected biochemical and electrophysiological aspects of memory; cognitive styles of

individual; teaching, administrative, and counseling styles of individuals; and systemic analysis and decision making (Hill, 1973:2).

Major Orientation

A major orientation is accorded an element of cognitive style if it occurs in the fiftieth through the ninty-ninth percentile range, inclusively, of a distribution of that element at a given developmental level (Hill, 1973:4).

Minor Orientation

A minor orientation is accorded an element of cognitive style if it occurs in the twenty-sixth through the forty-ninth percentile range, inclusively, of a distribution of that element at a given developmental level (Hill, 1973:4).

Modalities of Inference

Modalities of inference are the modes of reasoning used in deriving meaning and acquiring knowledge. The modalities of inference include the processes of magnitude, difference, relationship, and evaluation (Blosser, 1971:109).

Negligible Orientation

An element of cognitive style is considered negligible if it occurs in, or below, the twenty-fifth percentile in the distribution of that element at a given developmental level (Hill, 1973:4).

Secondary Student

A secondary student is one enrolled in the tenth, eleventh, or twelfth grade of a public high school.

Successful Science Student

A successful science student is a student who scores within the upper quartile range on the Test of Academic Progress: Science, Form 1, a science achievement test.

Symbols and Their Meanings

The symbols and their meanings are the theoretical and qualitative symbols employed by an individual in deriving meaning and acquiring knowledge (Blosser, 1971:103).

Unique Element of Cognitive Style

A unique element of a composite cognitive style is one which appears only in the composite cognitive style of either the "successful" group of science students or the "unsuccessful" group of science students.

Unsuccessful Science Student

An unsuccessful science student is a student who scores within the lower quartile range on the Test of Academic Progress: Science, Form 1, a science achievement test.

RESULTS

The study was designed to identify composite cognitive styles for successful and unsuccessful science students at the secondary level. Data were gathered from 351 students in the tenth, eleventh, and twelfth grades in the Mesquite Independent School District, Mesquite, Texas, during the Fall, 1975, trimester.

The variables of science achievement, knowledge of the scientific enterprise, attitude toward science, sexual differences, and grade level were considered. Not all variables will be discussed in this presentation. For further information see the unpublished dissertation, An Analysis of Cognitive Style Profiles and Related Science Achievement in the Secondary School, by Patricia M. Brewster.

Identification of Successful and Unsuccessful Students

Successful and unsuccessful science students at the secondary level were identified on the basis of science achievement as measured by the Test of Academic Progress: Science, Form 1. A frequency distribution of test results, according to percentile rank was constructed to indicate the distribution of scores within the sample population. For purposes of this study, successful science students were designated as those students scoring in the upper quartile range while unsuccessful science students were defined as those students scoring in the lower quartile range. The exact number in each group was determined by breaks occurring within the distribution near the quartile range. Accordingly, students scoring in the fifty-eighth through ninety-ninth percentile ranks were identified as successful science students and those scoring in the first through thirteenth percentile ranks were identified as unsuccessful science students.

The group of successful science students consisted of 83 students, 63 males and 20 females, as reported in Table 1. The unsuccessful science students totaled 91, 41 male and 50 female, as reported in Table 2.

Test of the Major Hypothesis

The major hypothesis of this study stated that there was not an identifiable composite cognitive style, constructed from individual cognitive style maps as determined by the Cognitive Style Mapping Booklet, for successful and unsuccessful science students. A composite cognitive style has been defined as those elements appearing in 70 percent of the cognitive styles of a group of subjects. The composite cognitive style identified for successful secondary science students is given in Figure 1. Table 3 shows the percentage occurrence of each of the common elements.

$$C = \begin{Bmatrix} Q(A) \\ Q(S) \\ Q(T) \\ Q(V) \\ Q(CES) \end{Bmatrix} \begin{Bmatrix} Q(CET) \\ Q(CP) \\ Q(CS) \\ Q(CTM) \end{Bmatrix} \times \begin{Bmatrix} F \end{Bmatrix} X \begin{Bmatrix} M \\ L \end{Bmatrix}$$

Figure 1.--Composite Cognitive Style for Successful Students

The successful science students exhibited a major orientation in each of the elements represented in the composite cognitive style. These students showed the ability to gain meaning through the senses of hearing, Q(A); taste, Q(S); touch, Q(T); and sight, Q(V).

Table 1

Description of the Group of Successful Science Students at the Secondary Level

Grade	Males	Females	Total
10	22	10	32
11	16	2	18
12	25	8	33
Totals	63	20	83

Table 2

Description of the Group of Unsuccessful Science Students at the Secondary Level

Grade	Males	Females	Total
10	12	8	20
11	18	36	54
12	11	6	17
Totals	41	50	91

Table 3

Percentage of Occurrence for Elements of the Composite Cognitive Style of Successful Science Students at the Secondary Level

Element	Symbol	Percentage Occurrence	Orientation
Ability to gain meaning through the sense of hearing	Q(A)	84	Major
Ability to gain meaning through the sense of taste	Q(S)	83	Major
Ability to gain meaning through the sense of touch	Q(T)	86	Major
Ability to gain meaning through the sense of sight	Q(V)	73	Major
Ability to enjoy the beauty of an idea of object	Q(CES)	73	Major
Commitment to a set of values, a group of principles, obligations, or duties	Q(CET)	70	Major
Ability to judge how close physically or socially you can get to another person	Q(CP)	86	Major
Personal knowledge of oneself	Q(CS)	81	Major
Ability to behave according to time expectations and limitations	Q(CT)	81	Major
Shows a major degree of influence by family members	F	73	Major
A form of categorical reasoning	M	90	Major
Reasoning that utilizes magnitude, difference, and relationships in reaching a conclusion	L	78	Major

These students had the ability to enjoy the beauty of an idea or object, Q(CES). They demonstrated a commitment to a set of values or group of principles, Q(CET), and were able to judge the correct physical and social distances to maintain in relationships with another person Q(CP).

Other elements in the composite cognitive style of successful science students included a personal knowledge of oneself, Q(CS), and a major degree of influence by family members, F. A form of categorical reasoning, M, and a reasoning pattern which utilizes magnitude, difference, and relationships in reaching conclusions, L, described the reasoning process of these students.

The elements identified as comprising the composite cognitive style of unsuccessful science students at the secondary level included minor orientations in two theoretical areas, t(aq), the ability to find meaning in terms of numerical symbols that are spoken, and t(vl), the ability to find meaning from words that are seen. An additional minor orientation was in deductive reasoning, (k) , reasoning that uses logical proof. The remaining elements of the composite cognitive style for unsuccessful science students included major orientations in the ability to gain meaning through the sense of taste, Q(S); through the sense of touch, Q(T); and through the sense of sight, Q(V). These students were able to judge the correct physical and social differences to maintain in relationships with others, Q(CP), and had a personal knowledge of themselves, Q(CS). They were able to behave according to time expectations and limitations, Q(CTM), and employed a form of categorical reasoning, M.

The composite cognitive style identified for the unsuccessful science student at the secondary level is given in Figure 2.

$$G = \left\{ \begin{matrix} t(aq) & Q(V) \\ t(vq) & Q(CP) \\ Q(S) & Q(CS) \\ Q(T) & Q(CTM) \end{matrix} \right\} \times \left\{ \right\} \times \left\{ \begin{matrix} M \\ (k) \end{matrix} \right\} .$$

Figure 2.--Composite Cognitive Style for Unsuccessful Students.

Table 4 presents the percentage of occurrence of each of the elements appearing in the composite cognitive style of unsuccessful science students in the individual cognitive styles of these students.

Composite cognitive styles for both successful and unsuccessful science students at the secondary level were identified according to the definitional criteria established for the composite cognitive style. Therefore, the null hypothesis was rejected.

Test of Sub-Hypothesis One

Sub-hypothesis one stated that there was no significant difference in the achievement in science, as measured by the Test of Academic Progress: Science, Form 1, between the successful and the unsuccessful science students in the secondary school. Analysis of variance compared the means of raw scores for the two groups. The mean score for the 83 successful science students was 36.44 while the mean score for the unsuccessful 91 students was 15.34 (see Table 5). An F-ratio of 607.46 was obtained. This exceeded the critical value of 3.89 required with 1 and 162 degrees of freedom for significance at the 0.05 level. The hypothesis was rejected.

Further analysis of the data relating to science achievement for the groups identified, employing Tukey's t-test, indicated that the differences identified by the F-ratio were between successful and unsuccessful science students. As indicated in Table 6, the t-test values obtained when comparing the means for the Test of Academic Progress: Science, Form 1,

Table 4

Percentage of Occurrence for Elements of the Composite Cognitive Style of Unsuccessful Science Students at the Secondary Level

Element	Symbol	Percentage Occurrence	Orientation
Ability to find meaning in terms of numerical symbols that are spoken	t(aq)	73	Minor
Ability to find meaning from words that are seen	t(vl)	71	Minor
Ability to gain meaning through the sense of taste	Q(S)	70	Major
Ability to gain meaning through the sense of touch	Q(T)	82	Major
Ability to find meaning through the sense of sight	Q(V)	70	Major
Ability to judge how close physically and socially you can get to another person	Q(CP)	72	Major
Personal knowledge of oneself	Q(CTM)	74	Major
Ability to behave according to time expectations and limitations	Q(CT)	71	Major
A form of categorical reasoning	M	70	Major
Reasoning that uses logical proof	(k)	74	Minor

Table 5

Comparison of Science Achievement, as Measured by the Test of Academic Progress: Science, Form 1, for Successful and Unsuccessful Science Students at the Secondary Level

Group	Mean	Standard Deviation
Successful Science Students	36.44	5.10
Unsuccessful Science Students	15.34	3.23

($F_{1/162}$-ratio = 607.46 $p < 0.05$)

for male and female successful science students and those for unsuccessful male and female science students did not reach the level required for significance at the alpha level of 0.05. The t-test values obtained by comparing the means of male or female successful science students with the means of male or female unsuccessful science students did surpass that value necessary for significance at the stated level. The data support the rejection of the hypothesis.

Test of Sub-Hypothesis Two

Sub-hypothesis two stated that there was no significant difference in the cognitive styles, as described by the Cognitive Style Mapping Booklet, of successful and unsuccessful science students at the secondary level. A chi square test of goodness of fit was performed for each element appearing in the cognitive style map. Negligible and minor orientations were combined to eliminate extremely small frequencies. Although there were differences in the frequencies of occurrence for each of the elements in the cognitive style map of successful and unsuccessful science students, significant differences were found in the occurrence of eight elements. These eight elements included ability to find meaning from words that are seen, ability to find meaning in terms of numerical symbols that are seen, ability to gain meaning through the sense of hearing ability to perform motor skills in an appreciated manner, ability to judge how close physically or socially one can get to another person, personal knowledge of oneself, a form of categorical reasoning, and reasoning that uses logical proof.

The required value of chi square for significance at the 0.05 level with one degree of freedom was 3.84. Table 7 presents the observed and expected frequencies of occurrence and the calculated chi square for each element in the composite cognitive style maps for successful and unsuccessful science students at the secondary level. Since significant differences were identified for elements within the cognitive style maps of the two groups, the null hypothesis was rejected.

Table 6

Table of t-Ratios for Scores on the Test of Academic Progress: Science, Form 1, for Successful and Unsuccessful Science Students at the Secondary Level

Group	Mean	Standard Deviation	t-Ratio
Successful, Male	36.70	5.08	
			0.83
Successful, Female	35.35	5.15	
Successful, Male	36.79	5.08	
			33.46*
Unsuccessful, Male	14.70	4.02	
Successful, Male	36.79	5.08	
			31.71*
Unsuccessful, Female	15.86	2.33	
Successful, Female	35.35	5.15	
			31.28*
Unsuccessful, Male	14.70	4.02	
Successful, Female	35.35	5.15	
			29.53*
Unsuccessful, Female	15.86	2.33	
Unsuccessful, Male	14.70	4.02	
			1.75
Unsuccessful, Female	15.86	2.33	

*Statistically significant at the 0.05 level
df=162

TABLE 7

Chi Square Values for the Elements of the Cognitive Style Maps of Successful and Unsuccessful Science Students at the Secondary Level

Element	Group	Major Orientation O	Major Orientation E	Minor-Negligible Orientation O	Minor-Negligible Orientation E	Total	Chi Square
Ability to find meaning through hearing spoken words T(AL)	S	34	40	57	51	91	2.04
	U	40	34	51	57	91	
	Total	74		108		182	
Ability to find meaning in terms of spoken numerical symbols T(AQ)	S	23	20	60	63	83	0.93
	U	19	22	72	69	91	
	Total	42		132		174	
Ability to find meaning from words that are seen T(VL)	S	46	32	37	51	83	9.19*
	U	21	35	70	56	91	
	Total	67		107		174	
Ability to find meaning in terms of numerical symbols that are seen T(VQ)	S	52	40	31	43	83	11.80*
	U	33	44	58	47	91	
	Total	85		89		174	
Ability to gain meaning through the sense of hearing Q(A)	S	70	58	13	25	83	17.62*
	U	52	64	39	27	91	
	Total	122		52		174	
Ability to gain meaning through the sense of smell Q(O)	S	47	48	36	35	83	0.08
	U	53	52	38	39	91	
	Total	100		74		174	
Ability to gain meaning through the sense of taste Q(S)	S	69	63	14	19	83	3.37
	U	64	69	27	22	91	
	Total	133		41		174	
Ability to gain meaning through the sense of touch Q(T)	S	72	70	11	13	83	0.70
	U	75	77	16	14	91	
	Total	147		27		174	

Table 7 (continued)

Element	Group	Major Orientation O	Major Orientation E	Minor-Negligible Orientation O	Minor-Negligible Orientation E	Total	Chi Square
Ability to gain meaning through the sense of sight Q(V)	S	61	60	25	23	83	0.12
	U	64	65	24	26	91	
	Total	125		49		174	
Ability to combine a number of associated symbols into the performance of a task Q(P)	S	49	49	34	38	83	1.33
	U	43	48	45	41	91	
	Total	92		79		174	
Sensitivity to the feelings of others Q(EM)	S	56	55	27	27	83	0.06
	U	61	61	30	30	91	
	Total	117		57		174	
Ability to enjoy the beauty of an idea or object Q(CES)	S	61	55	22	28	83	3.69
	U	54	60	37	31	91	
	Total	115		59		174	
Commitment to a set of values, a group of principles, obligations or duties Q(CET)	S	58	53	25	29	83	1.92
	U	54	59	37	33	91	
	Total	112		62		174	
Ability to play different roles to produce some particular effect on other people Q(CH)	S	42	37	41	46	83	2.32
	U	36	41	55	50	91	
	Total	78		96		174	
Ability to use body movements to communicate with others Q(CK)	S	33	33	50	50	83	0.00
	U	36	36	55	55	91	
	Total	69		105		174	
Ability to perform motor skills in an appreciated manner Q(CKH)	S	50	42	33	41	83	5.86*
	U	39	47	53	45	91	
	Total	89		86		174	

Table 7 (continued)

Element	Group	Major Orientation O	Major Orientation E	Minor-Negligible Orientation O	Minor-Negligible Orientation E	Total	Chi Square
Ability to judge how close physically or socially one can get to another person Q(CP)	S	72	66	11	17	83	3.99*
	U	66	72	25	19	91	
	Total	138		36		174	
Personal knowledge of oneself Q(CS)	S	53	58	10	16	83	5.18*
	U	68	63	23	17	91	
	Total	121		33		174	
Ability to positively influence others through interaction and communication Q(CT)	S	33	32	50	50	83	0.07
	U	34	35	57	56	91	
	Total	67		107		174	
Ability to behave according to time expectations and limitations Q(CTM)	S	68	63	15	20	83	3.19
	U	65	70	26	21	91	
	Total	133		41		174	
Shows a major degree of influence by friends and associates A	S	35	41	48	47	83	0.78
	U	41	45	50	51	91	
	Total	76		98		174	
Shows a major degree of influence by family members F	S	61	55	22	28	83	3.72
	U	55	61	36	30	91	
	Total	116		58		174	
Indicates significant independence in decision making I	S	55	51	28	32	83	1.54
	U	51	55	40	36	91	
	Total	106		68		174	
A form of categorical reasoning M	S	75	66	8	17	83	11.59*
	U	64	73	27	18	91	
	Total	139		35		174	

Table 7 (continued)

Element	Group	Major Orientation O	Major Orientation E	Minor-Negligible Orientation O	Minor-Negligible Orientation E	Total	Chi Square
Reasoning that is characterized in terms of one-to-one contrasts D	S	54	51	29	32	83	0.87
	U	53	56	38	35	91	
	Total	107		67		174	
Reasoning that employs an analysis of a situation to discover its componant parts R	S	52	47	31	36	83	2.33
	U	46	51	45	40	91	
	Total	98		76		174	
Reasoning that utilizes magnitude, difference, and relationships in reaching conclusions L	S	65	61	18	22	83	1.90
	U	63	67	28	24	91	
	Total	128		46		174	
Reasoning that uses logical proof (K)	S	37	25	46	58	83	15.00*
	U	16	27	75	63	91	
	Total	53		121		174	

*Significant at the 0.05 level

df=1

Test of Sub-Hypothesis Three

To determine whether there was a significant difference in the knowledge of the processes of science between successful and unsuccessful science students at the secondary level, the scores of the students on the Wisconsin Inventory of Science Processes were compared by analysis of variance (see Table 8). The mean score for successful science students was 50.05 while that of the unsuccessful group was 34.80.

The F-ratio obtained by the analysis of variance was 45.73 which was greater than 3.89, the value required for significance at the 0.05 level with 1 and 162 degrees of freedom. The data support the rejection of the null hypothesis.

Test of Sub-Hypothesis Four

Sub-hypothesis four stated that there was no significant difference in attitude toward science between successful and unsuccessful science students at the secondary level. Responses to an adaptation of the Hartman Science Attitude Test by the two groups were compared by analysis of variance. A constant of 30 was added to the tallied responses to produce positive scores for comparison. Scores below 30 indicated a negative attitude toward science and scores above 30 indicated a positive attitude. Sixty was the highest score possible.

The mean score for the successful group was 48.50 while that of the unsuccessful group was 42.90 (see Table 9) as both groups reflected a positive attitude toward science. The F-ratio obtained was 2.54. In that this value was less than the critical value of 3.89, the null hypothesis failed to be rejected.

Test of Sub-Hypothesis Five

Definitional criteria of the unique elements in the cognitive styles were employed to test sub-hypothesis five. This sub-hypothesis stated that there were no elements which were unique to the composite cognitive style identified for the successful science students at the secondary level. Comparison of the two composites revealed five elements that were unique to the

Table 8

Comparison of Knowledge of the Processes of Science, as Measured by the Wisconsin Inventory of Science Processes for Successful and Unsuccessful Science Students at the Secondary Level

Group	Mean	Standard Deviation
Successful Science Students	50.01	11.34
Unsuccessful Science Students	34.80	12.02

($F\text{-ratio}_{1/162} = 45.73$ $p < 0.05$)

Table 9

Comparison of Attitude Toward Science, as Measured by an Adaptation of the Hartman Science Attitude Test, for Successful and Unsuccessful Science Students at the Secondary Level

Group	Mean	Standard Deviation
Successful Science Students	48.50	7.39
Unsuccessful Science Students	42.90	11.54

($F\text{-ratio}_{1/162} = 2.54$ p 0.05)

successful group. These elements are presented in Table 10. Identification of the unique elements supports the rejection of the null hypothesis.

Test of Sub-Hypothesis Six

Sub-hypothesis six stated that there were no elements which were unique to the composite cognitive style identified for the unsuccessful science students at the secondary level . . . Comparison of the two composites revealed three elements unique to this composite cognitive style (see Table 11). Identification of the unique elements supports the rejection of the null hypothesis.

Table 10

Unique Elements in the Composite Cognitive Style of Successful Science Students at the Secondary Level when Compared to the Composite Cognitive Style of Unsuccessful Science Students at the Secondary Level

Element	Symbol	Orientation
Ability to gain meaning through the sense of hearing	Q(Λ)	Major
Ability to enjoy the beauty of an idea or an object	Q(CES)	Major
Commitment to a set of values, a group of principles, obligations or duties	Q(CET)	Major
Major degree of influence by family members	F	Major
Reasoning that utilizes magnitude, difference, and relationships in reaching conclusions	L	Major

Table 11

Unique Elements in the Composite Cognitive Style of Unsuccessful Science Students at the Secondary Level When Compared to the Composite Cognitive Style of Successful Science Students at the Secondary Level

Elements	Symbol	Orientation
Ability to find meaning in terms of spoken numerical symbols	t(aq)	Minor
Ability to find meaning from words that are seen	t(vl)	Minor
Reasoning that uses logical	(k)	Minor

EAST TEXAS STATE UNIVERSITY

MACH III SPECIAL SERVICES

Cognitive Style Map

SOCIAL SECURITY NUMBER: 12/03/75 NAME:

	DESCRIPTION	MODALITY	MAJOR	MINOR	NEGLI-GIBLE
1	Ability to find meaning through hearing spoken words	T(AL)		26	
2	Ability to find meaning in terms of numerical symbols that are spoken	T(AQ)	34		
3	Ability to find meaning from words you see	T(VL)	34		
4	Ability to find meaning in terms of numerical symbols that you see	T(VQ)	36		
5	Ability to gain meaning through the sense of hearing	Q(A)	40		
6	Ability to gain meaning through the sense of smell	Q(O)	34		
7	Ability to gain meaning through the sense of taste	Q(S)	38		
8	Ability to gain meaning through the sense of touch	Q(T)	38		
9	Ability to gain meaning through the sense of sight	Q(V)	38		
10	Ability to combine a number of associated symbols into a performance of a task	Q(P)	32		
11	Sensitivity to the feelings of others	Q(EM)	36		
12	Ability to enjoy the beauty of an idea or an object	Q(CES)	38		
13	Commitment to a set of values, a group of principles, obligations or duties	Q(CET)	36		
14	Ability to play different roles to produce some particular effect on others	Q(CH)	38		
15	Ability to use body movements (smiles, gestures) to communicate with others	Q(CK)	30		
16	Ability to perform motor skills in an appreciated manner	Q(CKH)	36		
17	Ability to judge how close physically or socially you can get to another person	Q(CP)	38		
18	Personal knowledge of oneself	Q(CS)	38		
19	Ability to positively influence others through interaction and communication	Q(CT)	34		
20	Ability to behave according to time expectations and limitations	Q(CTM)	32		
21	Shows a major degree of influence by friends and associates	Associates--A	34		
22	Shows a major degree of influence by family members	Family----F	36		
23	Indicates significant independence in decision making	Individual--I	40		
24	A form of categorical reasoning	Magnitude--M	38		
25	Reasoning that is characterized in terms of one-to-one contrasts	Difference--D	36		
26	Reasoning that employs an analysis of a situation to discover its componant parts	Relationship-R	36		
27	Reasoning that utilizes magnitude,differ,and relationships in reaching conclusion	Appraisal--L	34		
28	Reasoning that uses logical proof such as in geometry	Deductive-(K)	34		

EAST TEXAS STATE UNIVERSITY

MACH III SPECIAL SERVICES

Cognitive Style Map

SOCIAL SECURITY NUMBER: 12/03/75 NAME:

	DESCRIPTION	MODALITY	MAJOR	MINOR	NEGLI-GIBLE
1	Ability to find meaning through hearing spoken words----------	T(AL)		18	
2	Ability to find meaning in terms of numerical symbols that are spoken----------	T(AQ)		24	
3	Ability to find meaning from words you see----------	T(VL)		26	
4	Ability to find meaning in terms of numerical symbols that you see----------	T(VQ)		19	
5	Ability to gain meaning through the sense of hearing----------	Q(A)		22	
6	Ability to gain meaning through the sense of smell----------	Q(O)		21	
7	Ability to gain meaning through the sense of taste----------	Q(S)		18	
8	Ability to gain meaning through the sense of touch----------	Q(T)		22	
9	Ability to gain meaning through the sense of sight----------	Q(V)	28		
10	Ability to combine a number of associated symbols into a performance of a task---	Q(P)	27		
11	Sensitivity to the feelings of others----------	Q(EM)		18	
12	Ability to enjoy the beauty of an idea or an object----------	Q(CES)		22	
13	Commitment to a set of values, a group of principles, obligations or duties------	Q(CET)		19	
14	Ability to play different roles to produce some particular effect on others------	Q(CH)		24	
15	Ability to use body movements (smiles, gestures) to communicate with others------	Q(CK)		20	
16	Ability to perform motor skills in an appreciated manner----------	Q(CKH)		16	
17	Ability to judge how close physically or socially you can get to another person--	Q(CP)		17	
18	Personal knowledge of oneself----------	Q(CS)		17	
19	Ability to positively influence others through interaction and communication-----	Q(CT)	28		
20	Ability to behave according to time expectations and limitations----------	Q(CTM)		22	
21	Shows a major degree of influence by friends and associates----------	Associates--A		26	
22	Shows a major degree of influence by family members----------	Family----F	34		
23	Indicates significant independence in decision making----------	Individual--I		22	
24	A form of categorical reasoning----------	Magnitude--M		16	
25	Reasoning that is characterized in terms of one-to-one contrasts----------	Difference--D			12
26	Reasoning that employs an analysis of a situation to discover its componant parts	Relationship-R		25	
27	Reasoning that utilizes magnitude,differ,and relationships in reaching conclusion	Appraisal--L		26	
28	Reasoning that uses logical proof such as in geometry----------	Deductive-(K)		26	

20

23

24

BIBLOIGRAPHY

Allport, Gordon W. 1937. Personality: A Psychological Interpretation. New York: Holt Rhinehart-Winston.

Blanzy, James J. 1970. 'Cognitive Style as an Input to a Mathematics Curriculum System: An Exploratory Study on the Educational Sciences." Unpublished Doctoral dissertation, Wayne State University.

Blosser, Charles R. 1971. "A Pilot Study to Explore the Relationships Between Cognitive Style, Need Achievement, and Academic Achievement Motivation." Unpublished Doctoral dissertation, Wayne State University.

Bruner, Jerome S. 1966. Toward a Theory of Instruction, Cambridge: Belknap Press of Harvard University Press.

Hill, Joseph E. 1969. "Cognitive Style as an Educational Science." Unpublished paper, Oakland Community College, Bloomfield Hills, Michigan.

_____. 1973. Instructional Units and Problems Sets on Selected Aspects of the Educational Sciences. Bloomfield Hills, Michigan: Oakland Community College Press.

Hoogasian, Vaughn. 1970. "An Examination of Cognitive Style Profiles as Indicators of Performance Associated with a Selected Discipline." Unpublished Doctoral dissertation, Wayne State University.

Krejcie, Robert, and Daryle Morgan. 1970. "Determining Sample Size for Research Activities," Educational and Psychological Measurement, 30:607-610.

Shuert, Keith L. 1970. "A Study to Determine Whether a Selected Type of Cognitive Style Predisposes One to do Well in Mathematics." Unpublished Doctoral dissertation, Wayne State University.

Taba, Hilda. 1962. Curriculum Development Theory and Practice. New York: Harcourt, Brace and World, Incorporated.

Tyler, Ralph. 1933. "Pervailing Misconceptions," Journal of Higher Education, 45:288.

Warner, James L. 1970. "An Analysis of the Cognitive Styles of Community College Freshmen Enrolled in a Life Science Course." Unpublished Doctoral dissertation, Wayne State University.